

STAINING PREVENTION METHOD FOR DRY PART OF PAPER MACHINE AND  
STAINING INHIBITOR USED FOR THE METHOD

Field of the Invention

The present invention relates to a contamination-preventing method in a paper machine, and in particular to a method for preventing contamination of a portion contacting with a paper web in a dry part of a paper machine.

Background Art

A paper machine is provided with a drying means based upon a principle of heating for removing moisture, so called a dry part.

The dry part is provided with a plurality of cylindrical dryers for drying wet paper webs, and it occupies a major part of the paper machine.

In the paper machine, when a non-dried paper containing moisture is supplied to the dry part, this paper is pressed on a surface of a cylindrical dryer (which has a structure where heating is performed by causing steam to flow inside thereof) by a canvas and dried.

In general, since a surface of a cylindrical dryer made from a metal has a fine rough face and, particularly, a cylindrical dryer made from cast metal is broadly used, it cannot be avoided that such a rough face occurs on a surface of paper.

Now, pitch or tar content and additives contained in various papers or foreign matter particles, such as filler particles, are contained in paper.

In recent years, especially, much waste paper has been blended into raw materials for paper in view of recycling. Besides, there is a tendency that mixing of foreign matter particles such as fine fibers, hot melt, spine paste pitch made from vinyl acetate series increases.

When a paper adheres to a surface of a heated cylindrical dryer, such foreign matter particles become adhesive due to the heat and become fixed onto a surface of the cylindrical

dryer to form a contamination material thereon, thereby contaminating the cylindrical dryer.

According to an increase in projection on a surface of a paper, such an inclusion tends to be fixed on the cylindrical dryer surface relatively easily.

In order to remove contamination material fixed on the cylindrical dryer, a method for scraping the contamination material using a doctor blade, which is an auxiliary device for the cylindrical dryer, is usually used.

However, there is a problem that the cylindrical dryer surface is further made rough due to friction between the doctor blade and the dryer surface and the above foreign matter particles receive heat or pressure to enter in and fixedly adhere on the undulation portion on the rough surface.

As described above, foreign matter particles fixedly adhere on the cylindrical dryer or, simultaneously therewith, the texture on a paper surface is scrapped, which results in a direct or indirect adverse influence due to these foreign matter particles.

That is, the following specific defects occur.

1. Heat conductivity on a cylindrical dryer surface lowers, which results in a reduction in the drying rate of paper.
2. Peeling-off of paper surface, a so-called "picking" phenomenon, occurs easily.
3. Such a defect as a re-transfer of foreign matter particles grown on a dryer occurs.
4. Burning adhesion of paper on a cylindrical dryer surface and paper breaking occurs.
5. Undulation, fuzz or the like is caused on a surface of paper to be made.
6. Since paper particles are mixed in a product or a surface paper force is lowered, transfer blocking of ink to a paper surface, especially at a printing time, a so-called "void" phenomenon, occurs.
7. The number of periodic cleanings for a cylindrical dryer increases, which results in an increase in cost.

From the above, such a countermeasure is adopted that a cylindrical dryer whose surface has been subjected to chrome-plating treatment, polytetrafluoroethylene treatment, or the like, in advance is used or oil baking processing is periodically performed after the machine stops.

However, even in both of the countermeasures, when a cylindrical dryer which has been subjected to surface treatment is used for a long period, a treated surface gradually wears due to friction, which results in a considerable reduction in the contamination-preventing effect.

Therefore, change to a new cylindrical dryer is required, which results in a loss due to time for exchange and an increase in excessive cost.

Accordingly, an effect over a long period cannot be expected and continuous operation is improper for such a cylindrical dryer.

From these circumstances, an approach for solving these problems by spraying and applying a contamination-preventing agent to a surface of a cylindrical dryer itself directly and continuously in a region of a dry part is adopted (see Patent Literature 1).

Though this method is considerably effective, a spatial margin in the dry part region may be insufficient depending on the kind of paper machines.

In some cases, such a problem that an equipment space for arranging an equipment (a spraying and applying device) for spraying and applying a contamination-preventing agent cannot be secured occurs.

Further, though an approach for reciprocating a spraying nozzle in an axial direction of a cylindrical dryer to apply a contamination-preventing agent over an entire length of the cylindrical dryer evenly without discontinuity as much as possible is adopted in many spraying systems utilizing such a spraying and applying device, there is a technical limitation in the spraying and applying device. Therefore, when adhesive materials (foreign matter particles) increase in the raw

material, blurring may occur on a portion of the cylindrical dryer where the contamination-preventing agent is not present.

Further, the cylindrical dryer has a relatively large diameter, and it may be impossible to perform application over a whole surface of the cylindrical body evenly.

In such a situation, unevenness occurs regarding the contamination-preventing effect to the cylindrical dryer and fixation of foreign matter particles cannot be prevented effectively, so that such a spraying system does not constitute a reliable contamination-preventing means necessarily.

Further, as described above, blending of waste paper as raw material increases, but a lot of adhesive material (adhesive, sticky agent or the like) or foreign matter is included in waste paper in recent years, which results in ease of transfer to a cylindrical dryer surface.

Patent Literature 1: JP-A-2000-96478

#### Disclosure of the Invention

#### Problem to be solved by the Invention

The present invention is directed to solving the above various problems.

That is, an object of the present invention is to provide a method which can prevent contamination in a region of a dry part, at least a cylindrical dryer surface, effectively by a simple way, even if a paper machine does not include a spraying space.

#### Means for solving the Problem

Thus, as a result of keen repeated by research to these problems, the present inventors have found such a fact that a phenomenon that contamination material transfers from a paper web to a portion coming in contact with the paper web in a dry part, for example, a cylindrical dryer, can be prevented by supplying a contamination-preventing agent on a surface of the paper web in a stage before the paper web enters in the cylindrical dryer instead of spraying and applying the

contamination-preventing agent on a dryer surface, and they have completed the present invention based upon the finding.

That is, (1) the present invention lies in a method for preventing contamination of a contacting portion with a paper web in a dry part in a paper machine, where a contamination-preventing agent is continuously supplied and applied to a paper web before entering in the dry part.

(2) The present invention lies in a contamination-preventing method in a dry part, where the continuous supplying and applying the contamination-preventing agent to the paper web is constituted by indirect application to the paper web via an applying roller.

(3) The present invention lies in a contamination-preventing method in a dry part, where the continuous supplying and applying of the contamination-preventing agent to the paper web is constituted by indirect application to the paper web via a guide roller.

(4) The present invention lies in a contamination-preventing method in a dry part, where the continuous supplying and applying of the contamination-preventing agent to the paper web is constituted by indirect application to the paper web via a felt or a wire.

(5) The present invention lies in a contamination-preventing method in a dry part, where the continuous supplying and applying of the contamination-preventing agent to the paper web is constituted by direct application to the paper web using a spraying nozzle.

(6) The present invention lies in a contamination-preventing method in a dry part, where oil is used as the contamination-preventing agent.

(7) The present invention lies in a contamination-preventing method in a dry part, where the oil is a mineral oil, vegetable oil, animal oil, or synthetic oil.

(8) The present invention lies in a contamination-preventing method in a dry part, wherein an oil obtained by emulsifying an oil with a surface-active agent is used.

(9) The present invention lies in a contamination-preventing method in a dry part, wherein a polymer is used as the contamination-preventing agent.

(10) The present invention lies in a contamination-preventing method in a dry part, where the polymer serving as the contamination-preventing agent is an ampholyte copolymer obtained by polymerizing a mixture including a cationic monomer having an ethylene double bond and an anionic monomer having an ethylene double bond as essential components.

(11) The present invention lies in a contamination-preventing agent used in the contamination-preventing method in a dry part described in the above item (1), which is obtained by emulsifying a mineral oil, vegetable oil, animal oil, or synthetic oil using a surface-active agent.

(12) The present invention lies in a contamination-preventing agent used in the contamination-preventing method for a dry part described in the above item (1), which is an ampholyte copolymer obtained by polymerizing a mixture including a cationic monomer having an ethylene double bond and an anionic monomer having an ethylene double bond as essential components.

(13) The present invention lies in a contamination-preventing agent described in the above item (12), where the cationic monomer is a monomer having an ethylene double bond with amino groups ammonium base, or quaternary ammonium base.

(14) The present invention lies in contamination-preventing agent described in the above item (12) where the anionic monomer is a monomer having an ethylene double bond with carboxyl groups or an alkali metal salt thereof.

(15) The present invention lies in a contamination-preventing agent described in the above item (12), where the cationic monomer is at least one (including only one, of course) selected from the group consisting of compounds which are (meta)acrylic acid esters such as (meta)acrylic acid 2-(N,N-dimethylamino)ethylmethylchloride salt, (meta)acrylic acid 2-(N,N-dimethylamino)ethylbenzylchloride salt, and

(meta)acrylic acid 3-(N,N-dimethylamino)propylepichlorohydrin hydrochloride and which contain a quaternary ammonium chlorine.

(16) The present invention lies in a contamination-preventing agent described in the above item (12), where the anionic monomer is at least one (including only one, of course) selected from the group consisting of acrylic acid, methacrylic acid, itaconic acid, fumaric acid, succinic acid 2-(meta)acryloyloxyethyl, and hexahydrophthalate 2-(meta)acryloyloxyethyl.

(17) The present invention lies in a contamination-preventing agent used for the contamination-preventing method for a dry part described in claim 1, which is an ampholyte copolymer obtained by polymerizing a mixture including a cationic monomer having an ethylene double bond, an anionic monomer having an ethylene double bond, and a non-ionic (nonionic) monomer as essential components.

(18) The present invention lies in a contamination-preventing agent described in the above item (17), where the cationic monomer is at least one (including only one, of course) selected from the group consisting of compounds which are (meta)acrylic acid esters such as (meta)acrylic acid 2-(N,N-dimethylamino)ethylmethylchloride salt, (meta)acrylic acid 2-(N,N-dimethylamino)ethylbenzylchloride salt, and (meta)acrylic acid 3-(N,N-dimethylamino)propylepichlorohydrin hydrochloride and which contains a quaternary ammonium chlorine.

(19) The present invention lies in a contamination-preventing agent described in the above item (17), where the anionic monomer is at least one (including only one, of course) selected from acrylic acid, methacrylic acid, itaconic acid, fumaric acid, succinic acid 2-(meta)acryloyloxyethyl, and hexahydrophthalate 2-(meta)acryloyloxyethyl.

(20) The present invention lies in a contamination-preventing agent described in the above item (17), where the

number of carbon atoms is in a range of 6 to 50 in the non-ionic (nonionic) monomer.

(21) The present invention lies in contamination-preventing agent described in the above item (17), where the non-ionic (nonionic) monomer is polyethyleneglycolmono (meta)acrylate and/or polypropyleneglycolmono (meta)acrylate.

(22) The present invention lies in a method for preventing contamination of a contacting portion with a paper web in a dry part in a paper machine, where a contamination-preventing agent is continuously supplied and applied to a paper web before entering in the dry part, and a contamination-preventing agent is further continuously supplied and applied to a portion of the dry part which comes in contact with a paper web.

(23) The present invention lies in the contamination-preventing method for a dry part described in the item (22), where the portion of the dry part which comes in contact with a paper web is a dryer, a canvas, a calendar roll, a smoother roll, or a paper roll.

(24) The present invention lies in a contamination-preventing agent used for a contacting portion with a paper web in a dry part of a contamination-preventing agent described in the item (22), which is obtained by emulsifying a mineral oil, vegetable oil, animal oil, synthetic oil or wax using a surface-active agent.

The present invention can adopt any constitution obtained by combining two or more selected from the above items 1 to 24, if it satisfies the object of the present invention.

#### Operation

A sealing film is always formed and maintained so as to seal fine foreign matter particles on a surface of a paper web by continuously supplying and applying the contamination-preventing agent on the surface of the paper web before it enters in a dry part.

Transfer of foreign matter particles from a paper web to a contacting portion with a paper web in a dry part, for

example, a cylindrical dryer surface is prevented by the sealing film.

#### Effect of the Invention

By supplying and applying contamination-preventing agent to a paper web before the paper web enters in a dry part of a paper machine, a sealing film is formed on the paper and foreign matter particle contained in the paper web is sealed by the sealing film.

Since foreign matter particles do not come in direct contact with a portion coming in contact with a paper web, for example, a surface of a cylindrical dryer, transferring of the foreign matter particles does not occur, so that contamination of the cylindrical dryer is prevented.

Since a spraying and applying device is not disposed in a dry part, which is different from the conventional art, even if there is not a surplus space allowing arrangement of a spraying and applying device in the dry part, it is possible to prevent contamination of a portion coming in contact with a paper web, for example, a cylindrical dryer.

Contamination-preventing effect is prevented from being made uncertain due to the occurrence of application unevenness, which is different from the case where the contamination-preventing agent is directly sprayed and applied on a cylindrical dryer, so that contamination prevention is performed reliably.

Further, when the contamination-preventing agent is continuously supplied and applied to a paper web before it enters in a dry part and the contamination-preventing agent is continuously supplied and applied to a contacting portion coming with a paper web in the dry part of a paper machine, such as the dryers, canvas, calendar rolls and the like, the contamination-preventing effect to a whole machine is further improved.

#### BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 shows a specific example of a method for preventing the contamination of a cylindrical dryer in a paper machine of the present invention;

Fig. 2 shows a case that a roll coater is used as a means for supplying and applying a contamination-preventing agent indirectly;

Fig. 3 shows another example where a felt provided in a press part is used as the means for supplying and applying the contamination-preventing agent indirectly;

Fig. 4 shows a case that a spraying device is used as means for supplying and applying the contamination-preventing agent directly;

Figs. 5A and 5B are views illustratively showing a section of a paper web after the contamination-preventing agent has been applied to the paper web;

Fig. 6 shows experimental results showing the surface state of the dryer in Example 2; and

Fig. 7 is a diagram showing a wire part and a press part.

BEST MODE FOR CARRYING OUT THE INVENTION

The present invention will be explained with reference to the drawings showing the embodiments.

The present invention is directed to a technique where the contamination-preventing agent is continuously supplied and applied to a paper web being fed into a dry part in this paper machine so that a portion of the dry part which comes in contact with the paper web, for example, a cylindrical dryer or a canvas, is prevented from being contaminated.

Even if there is not a space for allowing the arrangement of a device for supplying and applying the contamination-preventing agent in a dryer part, sufficient effect can be achieved.

Fig. 1 shows one specific example of a method for preventing the contamination of a portion coming in contact with a paper web in a dry part of a paper machine of the present invention, for example, a cylindrical dryer.

In the paper machine, a drying portion (dryer part D) is disposed subsequent to a press part P, and the drying part is provided with heated cylindrical dryers D1, ..., canvases K1, ... which press a paper web W onto the dryers, canvas rollers for guiding the canvases, and the like.

The press part P is provided with press rolls P1, ..., and felts F2, ... which press a paper web W onto the press rolls to absorb moisture.

In a method illustrated, a contamination-preventing agent T is indirectly supplied and applied to a paper web W before it enters the paper machine via a guide roller 1.

Incidentally, in the case illustrated, an example where a press roll disposed just before entering the dry part is utilized as the guide roller.

A diluted liquid of contamination-preventing agent T is sprayed onto the guide roller 1 by a spraying and applying device (a spraying nozzle N) and the contamination-preventing agent T adhered on a surface of this guide roller 1 is transferred to a paper web W.

At that time, as described later, the contamination-preventing agent T is formed as a sealing film T1 so as to seal foreign matter particles.

The paper web W applied with the contamination-preventing agent T enters in the press part P where is squeezed and dehydrated by the press rolls and, thereafter, it is sent to the dry part D where it is heated and dried.

Fig. 2 shows another example that a roll coater process is used as a means for supplying and applying the contamination-preventing agent T indirectly.

Contamination-preventing agent T is applied from a contamination-preventing agent vessel 3 to a paper web W via an application roll 2.

Fig. 3 shows still another example that a felt provided in the press part P is used as a means for supplying and applying the contamination-preventing agent T indirectly.

In that case, a diluted solution of the contamination-preventing agent T is applied to a felt F4 disposed nearest the dry part D, for example by a spraying nozzle N with a full width (a so-called spray nozzle), and the applied agent is transferred to a paper web W.

In this Fig., the contamination-preventing agent T is transferred and applied to a back face of a paper web W.

The methods shown in Fig. 1, Fig. 2 and Fig. 3, described above, are shown as methods for supplying and applying the contamination-preventing agent T to a paper web W indirectly.

The method shown in Fig. 4 is directed to an example of a method for performing direct supplying and applying to a paper web W.

As the method for supplying and applying the contamination-preventing agent used here, a method for supplying and applying the diluted solution of contamination-preventing agent T using a spraying nozzle with a full width is adopted.

Incidentally, in an ordinary paper machine, a relatively sufficient free space is formed in a region where the spraying nozzle N shown in Fig. 4 is disposed or in a region where the roll coater shown in Fig. 2 is disposed, which is different from the dry part.

#### Contamination-Preventing Agent

Now, an oil or polymer is adopted as a specific contamination-preventing agent used in the present invention.

It is preferable that the oil is a mineral oil, vegetable oil, animal oil, synthetic oil (including a silicone oil), or the like, for example.

These oils may be used alone or in combination.

Since a dryer surface is heated to a high temperature (50°C to 120°C), an oil which does not denature at that temperature is selected.

It is preferable that the oil is added with a surface active agent to be emulsified with water so that the spraying thereof is made easy, as described later.

Such a constitution is adopted that a blending ratio of surface active agent is in a range of 5 to 70 weight % to oil, and the contamination-preventing agent added with water in an amount of 400 to 200000 times oil is used according to conditions such as paper making speed, paper width and the supplying and applying method of the contamination-preventing agent in a specific applying way.

As described later, since the polymer (usually a polymer solution) must have a proper adhesive function to a paper web, an amphotolyte copolymer obtained by polymerizing a mixture including a cationic monomer having an ethylene double bond and an anionic monomer having an ethylene double bond as essential components is excellent in contamination-preventing property and desirable.

The cationic monomer having an ethylene double bond may include a monomer having an ethylene double bond with amino groups, ammonium base, or quaternary ammonium base.

Specifically, compounds which are (meta)acrylic acid esters such as (meta) acrylic acid 2-(N,N-dimethylamino)ethylmethylechloride salt, (meta)acrylic acid 2-(N,N-dimethylamino)ethylbenzylchloride salt, and (meta)acrylic acid 3-(N,N-dimethylamino)propylepichlorohydrin hydrochloride and which contain quaternary ammonium chlorine can be adopted.

(Meta)acrylic acid 2-(N,N-dimethylamino)ethylmethylechloride salt, (meta)acrylic acid 2-(N,N-dimethylamino)ethylbenzylchloride salt is desirable from an effective aspect.

The anionic monomer having an ethylene double bond may include a monomer having an ethylene double bond with carboxyl groups or alkali metal salt thereof.

Specifically, acrylic acid, methacrylic acid, itaconic acid, fumaric acid, succinic acid 2-(meta)acryloyloxyethyl, or the like can be adopted.

Acrylic acid or methacrylic acid is desirable from an effective aspect.

Further, in view of effect, it is more preferable to polymerize a graphite chain-like material, for example, polyethyleneglycolmono (meta)acrylate and/or polypropyleneglycolmono (meta)acrylate, to the above-described ampholyte polymer as non-ionic (nonionic) monomer.

It is more preferable from an effective aspect that the number of carbon atoms is in a range of 6 to 50 as the non-ionic (nonionic) monomer.

Further, preferably, a material with a number of carbon atoms in a range of 10 to 40 develops a higher effect.

Incidentally, it is preferable that the ampholyte polymer includes the cationic monomer in a weight percentage of 40% or more.

#### Contamination-Preventing Principle

Now, a contamination-preventing agent T to be supplied and applied to a paper web W in the present invention is applied to a surface of a paper web so that it develops its original function when the paper web reaches the dry part D.

That is, the contamination-preventing agent T has such a function that foreign matter particles S (especially put in a projecting state) contained in the paper web W do not transfer to the dryer surface in the dry part D.

Fig. 5A and 5B are views illustratively showing sections of paper webs after contamination-preventing agents T have been supplied and applied to the paper webs.

By supplying and applying the contamination-preventing agent T to a paper web W, a sealing film T1 is formed to cover and seal foreign matter particles S put on a surface of the paper web in a projecting state.

When a paper web W comes in contact with a surface of the cylindrical dryer D which is a contacting portion in the dry part, since the paper web W comes in contact with the surface via the sealing film T1, the foreign matter particles S do not come in direct contact with the dryer surface.

Since the sealing film T1 develops a so-called "shielding function", the foreign matter particles S are prevented from

transferring to the cylindrical dryer surface to fixedly adhere thereto (see Fig. 5A).

The sealing film T1 having such a shielding function acts on the cylindrical dryer surface effectively when oil is used as the contamination-preventing agent T.

On the other hand, when a paper web W comes in contact with a surface of the cylindrical dryer D, since the sealing film T1 develops a function to be constrained by a paper web W, namely, "adhesive function", the sealing film T1 captures foreign matter particles S strongly without peeling off, so that the foreign matter particles are prevented from transferring and fixing to the dryer (see Fig. 5B).

The sealing film T1 having an adhesive function such as the latter serves to protect a dryer as surface effectively when a polymer is used as the contamination-containing agent T.

The principle described above can be applied to a canvas, of course.

Here, since it is required for a paper web applied in the present invention that the contamination-preventing agent T forms a sealing film, as described above, it goes without saying that the present invention cannot be applied to a paper machine for making tissue.

This is because a sealing film such as the present invention cannot be formed in paper quality such as tissue.

Now, as to a supply amount of the contamination-preventing agent (for example, oil), the contamination-preventing agent can be supplied and applied to such an extent that a thin film is formed so as to seal foreign matter particles adhered to a paper web.

Further, such a setting is employed that the supply amount of the contamination-preventing agent to a surface of a paper web is in a range of  $0.00001\text{mg}/\text{m}^2$  to  $10\text{mg}/\text{m}^2$ .

This range is effective in view of the prevention of an adverse influence to paper quality due to a formed state of a sealing film or an excessive film.

### Embodiment 1

As described above, the present invention is characterized in that the contamination-preventing agent is continuously supplied and applied to a paper web before entering the dry part. Further, by supplying and applying the contamination-preventing agent to a contacting portion with a paper web (for example, a dryer, a canvas, a calendar roll, a guide roll, or the like) in the dry part, a contamination-preventing effect to the whole machine can be further improved.

Incidentally, a calendar roll is generally arranged at an end section in the dry part and it is a portion which comes in pressure contact with a paper web to serve to improve the flatness of a surface thereof or the like.

For example, the dryer and the canvas of contacting portions with a paper web in the dry part is especially a portion easily contaminated.

Therefore, by supplying and applying the contamination-preventing agent to the dryer or the canvas continuously, the member itself is prevented from being contaminated (contamination-preventing agent can be supplied and applied to both the dryer and the canvas, of course).

As described in the conventional example, therefore, even if there is such a problem that a portion where the contamination-preventing agent is absent occurs on the cylindrical dryer according to the increase of adhesive material (foreign matter particles) in the raw material due to technical limitations in the spraying and applying device, the contamination-preventing agent has been supplied and applied to a paper web itself before entering in the dry part, any trouble does not occur.

Here, as the contamination-preventing agent to be supplied and applied to a contacting portion with a paper web in the dry part, for example, a mineral oil, vegetable oil, animal oil, synthetic oil (including a silicone oil or the like), was, polymer, or the like can be used.

Incidentally, as means for performing supplying and applying to a dryer or a canvas, a spraying nozzle such as described previously can be used.

Further, the contamination-preventing agent is diluted with water whose amount is 400 to 200000 times the agent in advance for performing spraying over a paper width evenly and it is distributed using a spraying nozzle with a full width.

#### Embodiment 2

As described above, the present invention is characterized in that the contamination-preventing agent is continuously supplied and applied to a paper web before entering in the dry part, but it can functionally achieve a similar effect on a roll (a paper roll or a smoother roll) positioned in a region defined to be included in the dry part region.

In that case, the expression "a paper web before entering the dry part" means "a paper web before reaching a paper roll or a smoother roll".

That is, it is necessary to supply and apply the contamination-preventing agent to a paper web before reaching the paper roll or the smoother roll continuously.

With such a constitution, a sealing film is formed and foreign matter particles included in the paper web are sealed.

By forming the sealing film, foreign matter particles are prevented from coming in direct contact with a surface of the paper roll and the smoother roll, which is a portion coming in contact with a paper web, and transfer thereof is prevented so that the paper roll and the smoother roll are prevented from being contaminated.

#### (Examples)

Next, spreading experimental results of the contamination-preventing agent in the present invention are shown.

#### Example 1

In a multi-cylinder dryer type paper machine (manufactured by Kobayashi Engineering Works., Ltd.) such as

shown in Fig. 1, after an operation where the contamination-preventing agent was continuously supplied and applied to a paper web before entering into a dry part (via the press roll P4 shown in Fig. 1) was performed for 8 hours, the surface state of a dryer (the dryer D1 in Fig. 1) was observed at that time point.

The quality of the paper (here, white board paper) produced during the operation was inspected visually.

(Contamination-preventing agent used)

The contamination-preventing agent used here was an emulsified aqueous solution (10% concentration, 1.0g/cc) obtained by mixing a vegetable oil, a surface-active agent and water.

(Spraying amount)

5cc/minutes

Incidentally, the emulsified aqueous solution with this amount was diluted with water to 1000 times and spraying was performed at a rate of 1L/minute.

Here, the area of the paper passing through was 200m<sup>2</sup> (paper width: 2m; making speed: 100m/minute), and the supply amount of the vegetable oil was

$$5\text{cc/minute} \times 1.0\text{g/cc} \times 0.1 \div 200\text{m}^2/\text{minute} = 0.0025\text{g/m}^2 = 2.5\text{mg/m}^2.$$

(Result)

From the result of the observation of the dry part after 8 hours had elapsed, it was found that there was not any adhesion material on a surface of the cylindrical dryer and the surface appeared as a mirror face.

Further, the gloss level on a paper surface was excellent.

Example 2

In a multi-cylinder dryer type paper machine (manufactured by Kobayashi Engineering Works, Ltd.), after an operation where the contamination-preventing agent was continuously supplied and applied to a paper web before entering in a dry part (via the press roll P4t shown in

Fig. 1) was performed for 8 hours, the surface state of a dryer was observed at that time point.

In this case, the amount of contamination, such as paper fine particles adhered on a dryer surface (the surface of the dryer D1 shown in Fig. 1), was measured.

Incidentally, the smaller the amount, the more significant the contamination-preventing effect on a surface of a dryer.

Here, the amount of contamination was indicated in an index manner based upon the definition that a case where no contamination-preventing agent was adhered on the press roll P4t was 1.

Further, the quality of the paper (here, a low class printing paper) produced during the operation was inspected visually.

(Spraying amount)

3cc/minute

Incidentally, the emulsified aqueous solution with this amount was diluted with water to 4000 times and spraying was performed at a rate of 14L/minute.

Here, the area of a paper passing through was  $3000\text{m}^2$  (paper width: 4m; making speed: 750m/minute) and the supply amount of ampholyte copolymer was  
 $3\text{cc/minute} \times 1.0\text{g/cc} \times 0.02 \div 3000\text{m}^2/\text{minute} = 0.00002\text{g/m}^2 = 0.02\text{mg/m}^2$ .

(Contamination-preventing agent used)

The contamination-preventing agent used here was a polymer and an experiment for applying contamination-preventing agent A, contamination-preventing agent B, contamination-preventing agent C and contamination-preventing agent D onto a paper web was conducted.

Each of the contamination-preventing agents A to D was a 2% polymer aqueous solution.

The contamination-preventing agent A was a 2 weight % aqueous solution of an aqueous polymer mainly containing a polymer of a cationic monomer and an anionic monomer (weight

ratio of 5:5), the contamination-preventing agent B was a 2 weight % aqueous solution of an aqueous polymer mainly containing a polymer of a cationic monomer and an anionic monomer (weight ratio of 8:2) and the contamination-preventing agent C was a 2 weight % aqueous solution of an aqueous polymer mainly containing a polymer of a cationic monomer, an anionic monomer and a nonionic monomer (weight ratio of 5:2:3).

The contamination-preventing agent D was a 2 weight % aqueous solution of an aqueous polymer mainly containing a cationic monomer.

The cationic monomer was (meta)acrylic acid 2-(N,N-dimethylamino)ethylbenzylchloride salt.

The anionic monomer was methacrylic acid.

The nonionic monomer was polyethyleneglycolmono(meta)acrylate.

As the method for applying these contamination-preventing agents on the press roll, a method was adopted that each of the contamination-preventing agents described above was diluted with water by 4000 times to be sprayed by the spraying nozzle N shown in Fig. 3, where the application was conducted at a rate of 3cc/minutes on a concentration solution base.

The above experiment result is shown in Fig. 6 (a surface state of the dryer).

#### (Result)

From the result of observation of the dry part after 8 hours had elapsed, it was found that the amount of contamination adhered on the surface of the cylindrical dryer D1 was reduced in each case. Regarding the contamination-preventing agent C, the amount of contamination was reduced down to 1/10 of the case where the contamination-preventing agent was not applied to press roll P4t.

The smoothness of a surface of a paper produced during the experiment was excellent.

#### Other Examples

The present inventors conducted an experiment which indirectly applied a contamination-preventing agent on a paper web via the wire disposed in the wire part and they obtained a similar finding.

For your reference, the wire part is a region which is positioned upstream of the press part, as shown in Fig. 7.

The wire w is spanned by guide rolls and slurry-like pulp supplied from a head box H above is placed on the wire w in a thin film manner and conveyed to the press part.

At that time, water contained in the slurry-like pulp is removed.

Though the present invention has been explained above, the present invention is not limited to these Examples. It goes without saying that the present invention can be modified without departing from the essence of the present invention.

The present invention can be sufficiently applied to any portion with which a paper web comes in contact in the dry part, and it is effective for contamination prevention to not only the above-described dryer, canvas and calendar roll but also a paper roll for guiding a paper web or the like, of course.

Besides, the dry part is provided with parts such as a guide roll for a paper web, and the present invention is applicable to such parts, of course.

Further, as explained in the second embodiment, the present invention is functionally effective for a roll, that is, the paper roll or the smoother roll (not shown), in a region which is substantially included in the dry part.

In that case, of course, the contamination-preventing agent is continuously supplied and applied to a paper before the paper web reaches the paper roll or the smoother roll.

#### Industrial Applicability

The present invention relates to a contamination-preventing method for a dry part in a paper machine, but it is applicable to all the paper-making technical fields without

department from its principle, where a similar effect can be expected.